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Marian C. Fisher
State University of Iowa

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A COMPARATIVE MORPHOLOGICAL STUDY OF CERTAIN SPECIES OF THE DACRYOMYCETACEAE

MARIAN C. FISHER

The family Dacryomycetaceae is here regarded as belonging to the Tremellales. Members of this family are common, occurring on dead wood. They are dull and inconspicuous when dry, but when moist they are brightly colored and more noticeable. The fructifications range in size from that of a pin-head up to dimensions of several centimeters, and in shape from broadly effused through pulvinate and resupinate to upright forms which may be stalked and capitate, cupulate, spathulate or awl-shaped. They may or may not be rooted in the substratum. The consistence varies from soft gelatinous to sub-cartilaginous. Because of their wood rotting habit, and because they are sometimes extremely abundant, they are obviously of more or less economic importance. The extent of their activity as wood destroying fungi has not as yet been adequately investigated.

The surface of the fructification is covered by a hymenium, composed of the characteristic forked basidia, accompanied by paraphyses. The forked basidium is the constant character of the family. The basidium starts as a cylindrical and more or less clavate structure which sends out at, or just below the tip two lateral branches which taper more or less gradually and bear at the tip of each branch a sterigma and a spore. The spores are oblong, smooth, cylindrical, often bent, having at one end a hilum just to one side of the point of attachment, so that the hilum is toward the axis of the basidium. The spores, the manner in which they are borne, and their discharge is typical of the Basidiomycetes. After the basidium discharges its spores, it becomes transparent, and the branches shrink, becoming more or less thread-like in appearance. Spore prints may be obtained at the time of fruiting; these range in color from pale yellow, almost white, to deep orange. After the spore has been shed it usually divides before germination, by transverse septa, into two to several cells. Germination is commonly by sporidia borne singly or in chains on short sterigmata. They may be of various shapes, the shape seemingly being constant for a given species. Occasionally the spores germinate by the direct production of mycelium.

The earlier descriptions of the species such as may be found in the works of Persoon and Fries (7), were based on the exterior characters only, consequently the Dacryomycetaceae and Tremellaceae were not clearly distinguished. Tulasne (15) was the first to describe the distinctive forked basidia of the Dacryomycetaceae and to separate them from the other tremellaceous fungi. He made very careful microscopic studies, and described fully the internal structure, the formation of sporidia, and the oidial stage of *Dacryomyces deliquescens*. Brefeld (2) made an intensive study of certain species. Because of the non-septate basidia, he included the family in the Autobasidiomycetes, which also included such forms as the Thelephoraceae and Agaricaceae, as opposed to the Protobasidiomycetes in which he placed the rusts and tremellaceous fungi with septate basidia. Patouillard, (12), on the other hand, placed the Dacryomycetaceae with the Tremellales and other forms with heterobasidia, making up the sub-class Heterobasidiomycetes. This classification is adopted by G. W. Martin at the University of Iowa, under whose direction these studies have been made. It may be noted here that I have found septate basidia predominant in some collections of *Dacryomyces minor* (fig. 2), and occasionally in other species. The septa were very irregularly arranged, however, and probably not of the same character as those of the regularly septate forms. According to Neuhoﬀ (11) the young basidium is equivalent to the probasidium of the Tremellales; after the development of the two lateral branches, the lower part becomes the hypobasidium, and the branches may be termed epibasidia. The branches have frequently been regarded as sterigmata. Neuhoﬀ, however, regards them as part of the basidium, for each bears at its tip a true sterigma and spore.

In the literature the taxonomy of the group is greatly confused. The generic distinctions are vague. The structure of the basidiocarp is most often used to distinguish the genera, but in some cases where there are intermediate forms the limitations of the genera are not distinct. Furthermore, there is great disagreement in the application of generic names; the same form may be treated under one genus by one author, and under a different genus by another. For example, *Dacryopsis nuda* Masee, is regarded by Burt (4) as a *Dacryomitra*. Likewise, within the genera there is considerable disagreement as to the species. The descriptions are often not clear enough to permit differentiation. Characters have been used which probably are not of taxonomic significance, such as color and habitat. Whether the substratum is coniferous or de-

ciduous wood, has, in some cases, been considered important; this, however, must be regarded as an essentially secondary taxonomic character.

The group as a whole has suffered from comparative neglect. A thorough knowledge of the comparative morphology of all the species is needed in order to settle the confused taxonomic state of this family. In an attempt to help clarify this situation, the present studies have been made. The species studied in detail were *Dacryomyces minor*, *Dacryomyces deliquescens*, *Dacryomyces Ellissi*, *Calocera cornea*, *Dacryopsis nuda*, *Guepiniopsis spathularia*, and *Guepiniopsis elegans*, all of which were collected in the vicinity of Iowa City. In addition to the examination of living and soaked specimens giving the external and microscopic characters, the structure has been determined from prepared longitudinal and transverse sections.

Dacryomyces deliquescens (Bull.) Duby

The basidiocarps are from 1.5-4 mm. in diameter, sometimes confluent in large patches. They are at first circular, somewhat pulvinate, tending to become flattened when older. Sometimes they are slightly folded or wrinkled. The color is usually a more or less bright yellow, but may range from a very pale straw color to an orange-yellow, becoming orange or brownish upon drying. They are sessile or sub-stipitate and often have a somewhat flattened root of varying length, usually short (Fig. 4).

A longitudinal section (Fig. 5) shows the closely packed mycelium of the root, in some cases a slightly uneven outline of the surface, and the hymenium extending, for the most part, only over the superior surface. The spores are oblong, cylindrical, averaging 11-12.5 x 5.1 microns, dividing into 4 cells before germinating to form globose, or ovoid sporidia (Fig. 6); or they may germinate directly into a delicate mycelium. The spore print is a pale yellow.

This species has been reported as growing on either deciduous or coniferous wood. The specimens that I have examined were on deciduous wood only.

This species was first described by Bulliard (3) as *Tremella deliquescens*, then by Duby (6) as *Dacryomyces deliquescens*. Other descriptions of this species throughout the literature are rather confusing as to color, size, rooting or not, and habitat. Lloyd (9) suggests that the *D. deliquescens* described in England is not the same as that described in America. The species that I refer to *D. minor* Peck, has probably been included in *D. deliquescens* in many cases; as for example, by Bourdot and Galzin (1)

who describe it as minute, and yellow amber. One of the reasons that I have kept Peck's species is that this form is sessile and not rooting, while there are indications that *D. deliquescens* is sub-stipitate and more or less rooting. The illustrations by Bulliard (3) show it to be a substipitate form. Rea (14) describes it as substipitate and root-like. Saccardo describes it as more or less rooted.

Dacryomyces minor Peck

The fruiting bodies are very small, from 1.5-2 mm. in diameter, sometimes anastomosing to form clumps up to 4 mm. broad. They are usually a dull greenish amber color, or a smoky yellow. The texture is firmly gelatinous. The form is pulvinate, being sometimes flattened, the surface usually smooth. The older fructifications may become somewhat wrinkled, particularly when growing in clumps. They appear sessile, are attached by a point, and have no signs of rooting (Fig. 1). The very young individuals are sometimes covered at first by a white, flocculent coat, the smooth, glabrous body first appearing as a disk on the top. This character, however, was the exception in the material that I studied. There were some so young that they were scarcely visible that had no covering.

A longitudinal section (Fig. 3) of an individual shows that the hymenial surface extends over the top and as far down on the sides as half way (or a little more) between the top and lower surfaces, coming to an end quite abruptly. The point of attachment is a small slender, stalk-like portion, so short that it does not raise the head above the substratum. In this region the hyphae are closely packed and run longitudinally; then they diverge into the loose, branching mycelium of the body.

The hymenium is composed of clavate paraphyses and the characteristic forked basidia. Quite commonly the paraphyses and the basidia may be septate (Fig. 2); the septa in one paraphysis or basidium sometimes numbering as many as eight. The spores are oblong, cylindrical, and slightly bent, 10.5-14.7x4.7-5.6 microns; becoming four-celled before germinating to form oblong sporidia, 3.1 microns long (Fig. 2). The spore print is *capucine yellow.

This species is found on deciduous or coniferous wood. The ones that I examined were on white cedar and apple. In both cases the wood was decorticated.

Burt (4) includes this species in *D. deliquescens*. I believe that it should be kept distinct as *Dacryomyces minor* as first described

* An asterisk indicates a color referred to in Ridgway's color standards.

by Peck (13) and maintained later by Coker (5). It can be quite readily recognized by the *italicized* characters in the above description, and these characters set it apart as distinct from *D. deliquescens*.

Dacryomyces Ellisii Coker

The basidiocarps range in size from 1-4.5 mm. broad, and up to 3 mm. high. However, several individuals may be crowded together to form a much larger mass. They are usually much convoluted, and seldom smooth. They often emerge from cracks in the bark and are rooted with a flat, whitish, fibrous root which extends down through the bark for about 3-6 mm. When growing gregariously their roots are often united (Fig. 7). The color is orange, drying dull wine red; the texture is firmly gelatinous.

A longitudinal section (Fig. 9) shows that the hymenium covers the surface, extending normally to the under surface. In some cases, however, it may be lacking from part of one or both sides; this is probably the case when the bark prevents these regions from being exposed to the exterior. The root is composed of closely packed longitudinal hyphae which lead out to the more loosely arranged, branching hyphae of the basidiocarp. The hyphae may have a rough-edged appearance, which was apparent in all the individuals that I examined; this character is not, however, peculiar to *D. Ellisii*. The spores are kidney shaped, the size averaging 13.1 x 5 microns, becoming four celled before germinating to form egg-shaped sporidia (Fig. 8). The spore print is * Mikado orange.

This species seems to be quite distinct. It is surely a Dacryomyces because of the absence of the stalk and the extent of the hymenium. It differs from *D. deliquescens* and *D. minor* by its large, white root, and from *D. aurantius* and *D. stillatus* by the size and septation of the spores.

Key to the Iowa Species of Dacryomyces

- a. Greenish amber, attached by a point, 1.5-2 mm. in dia., pulvinate, sometimes slightly folded, single or gregarious, spores 10-14.7x4.7-5.6 microns.....1. *D. minor*
- a. Not greenish amber, averaging more than 2 mm. in dia.....b.
- b. Orange to dull yellow, attached by a point or with a short root, 1.5-4 mm. in dia., pulvinate or irregularly convoluted, spores about 11x5 microns.....2. *D. deliquescens*
- b. Bright orange to pale yellow with a long, flat fibrous root, 2-5 mm. in dia., often gregarious, pulvinate when young, convoluted when older, spores about 13x5 microns.....3. *D. Ellisii*

Calocera cornea Fr.

The fructifications of this species are variable in size. In one collection they varied from 3-5 mm. in height, the average thickness of a single individual being about 0.5 mm. (Fig. 11). Those of another collection measured 3-11 mm. in height, with a diameter of about 1.5 mm. (Fig. 10). They have slender, upright bodies which are cylindrical and pointed at the end, so that they are awl-shaped when simple. They may be somewhat branching in a clavaria-like manner. I have found an occasional individual which appeared unusually broad at the region of branching, suggesting the flat, broad form of *C. palmata* (Fig. 11). Their growth may be single or caespitose, in the latter case they may anastomose at the base. They are usually not definitely rooting, but when growing on wood with the bark attached, the lower portion may extend in root-like fashion to the wood. If the base does not penetrate the substratum it is often slightly thickened where in contact with it. The fructifications are firmly gelatinous to tough, and more or less viscid. The color ranges from *maize yellow (pale) to *mars yellow (light brownish yellow), being usually lighter colored at the base, drying darker, sometimes to a wine color.

A longitudinal section (Fig. 14) shows the hymenium extending over the entire surface. The hymenium is composed of clavate paraphyses and the characteristic forked basidia. The hyphae run through the center of the basidiocarp in closely packed longitudinal strands, marking off a central portion about one-half of the whole diameter in width, and clearly defined from the more loosely arranged hyphae directed obliquely upwards to the hymenium. The two regions are differentiated also by staining; in Flemming's triple stain, the inner region taking, for the most part, the violet, and the outer region the orange. The base of the inner mycelial region is in contact with the substratum, but at the top it is surrounded by the outer mycelial region. The spores are oblong, cylindrical and slightly bent. The spore print is *light orange yellow. They average 9.4 x 3.6 microns; and become two-celled before germinating to form spherical sporidia, (Fig. 12).

C. cornea is found commonly on coniferous or deciduous wood. There is a wide variation in size and shape. I noticed the widest variations between forms growing on deciduous, and those on coniferous wood. One variation is that of size which was mentioned above; those on the coniferous wood had the smaller dimensions, they tended to grow singly rather than caespitose, and were slightly tougher. I could obtain no spores of the forms on the

coniferous wood. Coker (5) described a separate variety of *C. cornea* on pine, as being only up to 2 mm. high.

C. cornea may be distinguished from *C. viscosa* by its smaller size and paler color; from *C. striata* by the absence of the striate character. It is the only species of *Calocera* that I have found in Iowa.

Dacryopsis nuda Massee

The fruiting body of *Dacryopsis nuda* is stalked and has a pulvinate head, usually somewhat flattened, smooth or slightly folded, firmly gelatinous, and 1-3 mm. in diameter. The stalk is tough cartilaginous, cylindrical, about 1 mm. in diameter and 1-2 mm. high; it may extend into the bark, but the basidiocarp is not definitely rooting. It may be compound, one stalk subtending two or more fruiting heads (Fig. 20). The head varies in color from yellow to amber, and the stalk is darker and brownish. The very young individuals are covered with a white, fibrous coat. This covering persists over the stalk and growing head until the head has expanded to almost full size.

A longitudinal section (Fig. 19) shows the fine, closely packed mycelium of the stalk, and the loosely arranged mycelium of the head. The hymenium extends over the superior surface of the head and down the sides almost to the inferior surface. It is clearly shown that the stalk of the specimen sectioned is superior to the substratum; and that there is no definite root, but only strands of mycelium extending down between the wood cells. The spores are oblong, cylindrical, averaging 15.7 x 5.2 microns, and becoming 1-5-celled, usually 4-celled, before germinating to form ovoid sporidia (Fig. 21). The spore print is a bright yellow.

This species was found on decorticated elm.

The specimens that I examined agree very well with the description and illustration of *Dacryopsis nuda* by Massee. Coker (5) changed the species which he described as *Ditiola radicata* to *Dacryopsis nuda*. His description does not, however, agree with that of Massee. It is quite different in that it has a convoluted head, stalk submerged in the substratum and a flat white root. Burt (4) regards Massee's genus *Dacryopsis* as superfluous and merges the genus with *Dacryomitra*. *Dacryopsis nuda* as studied is quite distinct and it seems desirable to maintain the genus, at least until these forms are better understood.

Guepiniopsis spathularius (Schw.) Pat.

Guepiniopsis spathularius, commonly referred to as *Guepinia spathularia*, is one of the most conspicuous of the Dacryomyceta-

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ceae because of its large and brightly colored fruiting body. The height usually ranges from 5-10 mm. and the width of the widest region from 4-7 mm. One specimen measured 27 mm. from the base of the root to the top of the fructification. When moist the color is orange: upon drying the hymenium becomes a dull wine color, and the sterile portion, including the stalk, becomes a brownish white.

The form is upright, spatulate and stalked. The stalk extends from $\frac{1}{3}$ to $\frac{1}{2}$ the height of the whole body, and tends to be cylindrical at the base and flattened at the top. The hymenium covers only one side of the spatulate portion which sometimes curls or bends to one side, so that the hymenium is toward the substratum. The hymenial surface is veined longitudinally. The top may be broad and irregular or a blunt point. Commonly, the fructifications arise from cracks in corticated or decorticated wood, in linear arrangement, more or less united at the base as a common, flat, tough, gelatinous root about 4 mm. deep. The stalks may also be united at the base giving the appearance of branching (Fig. 15).

A longitudinal section (Fig. 16) shows the very dense hyphae of the root, the longitudinally directed hyphae of the stalk gradually spreading out to the loose branching hyphae of the top. There is often a space running through the central portion of the stalk and widening to some extent in the head, containing gelatine. The stalk and sterile portion of the head are hairy, the hairs longer at the base of the stalk, and becoming shorter until they are minute on the head. A cross section (Fig. 17) of the hymenial portion shows the veins to be so arranged that there are notch-like spaces intervening. The hymenium follows the outline continuously. The hymenium is composed of clavate paraphyses and the characteristic forked basidia. The spores average 9.2×3.6 microns. They become two-celled before germinating to form spherical sporidia (Fig. 18); less often they germinate to form primary mycelium. The spore print is *orange.

The forms that I studied were growing on decorticated, deciduous wood. Coker reports forms on cedar and pine.

The species is very distinct and definite and could not well be confused with any other.

Guepiniopsis elegans (B. & C.) Pat.

This is *Guepinia elegans* B. and C.

This species differs from other Dacryomycetaceae by its deep amber brown, almost black color. The younger fruiting bodies are

a lighter amber color; the older ones, darker, the fruiting surface being almost black. The basidiocarp usually grows to a height of from 12 to 16 mm. Bourdot and Galzin (1) and Killermann (8) report them up to 15 mm.; and Coker (5) to 20 mm. However, a collection by G. W. Martin, made at Homestead, Iowa, and found on box-elder, exceeded in size any reports that I can find. The largest individual of these was old and in poor condition; the top portion was lacking. Even so, the remains measured 50 mm. of which the stalk was 27 mm. Measurements of other specimens were — height, 28 mm. (of which 14 mm. was stalk), width 16 mm.; height 33 mm. (of which 16 mm. was stalk), width 20 mm. The youngest fruiting bodies are stalked and obliquely cup-shaped; (Fig. 22); the older ones stalked and fan-shaped or spatulate (Fig. 23). It appears that one side of the cup of the young individual grows at a more rapid rate than the other, until the cup shape is lost and the more rapidly growing side becomes the fan-shaped portion of the older form. On the cup-shaped form the hymenium extends over the interior of the cup; in the fan-shaped form, only on one side. The sterile side of the head and stalk are finely tomentose on the surface. The stalks of the very large forms when dry appear tough and woody, and are covered by a very thick brown tomentum.

A longitudinal section (Fig. 26) of a cupulate form shows that the mycelium of the whole body tends to run in parallel longitudinal arrangement. At the base of the stalk the hyphae are the most compact. The hyphae directly under the hymenium run horizontally to it, except at the base of the cup.

The individuals, large and small, in the collection referred to above with the exceedingly large sized fructifications, possessed hyphae with particularly large swellings at the septa (Fig. 24). The other specimens of this species that were studied, had infrequently comparatively slight swellings near the septa.

The spores are oblong, cylindrical, bent, averaging 11.3×5.2 microns, and becoming four celled before germinating to form ovoid sporidia. (Fig. 25).

SUMMARY

Among the many species of *Dacryomyces* which are mentioned in the confused literature in this genus, three may be distinguished which include all the species known from Iowa. These are all forms with three-septate spores.

1. *D. minor* Pk. is characterized by being sessile, small and pulvinate in shape, and of a greenish amber color;

2. *D. deliquescens* (Bull.) Duby by being substipitate or rooting with a short root and having an orange to dull yellow color;

3. *D. Ellisii* Coker by its larger size and long, white fibrous root.

Calocera cornea Fr. may vary in size and consistency according to whether the substratum is coniferous or deciduous wood. However, since the differences are not very great, and intermediate forms occur, the specimens may be included in a single species, since the other characters remain constant. The basidiocarp has a distinct central region characterized by closely packed, longitudinally directed hyphae.

Dacryopsis nuda Massee is characterized by a tough gelatinous stalk and a flatly pulvinate head. This form agrees very well with Massee's original description.

Guepiniopsis elegans (B. and C.) Pat. with its brownish black color and cupulate or fan-shaped form is easily recognized. The hyphae run in parallel arrangement throughout the fruiting body. Some specimens studied exceed in size any previous report.

Guepiniopsis spatularius (Schw.) Pat. is a distinct species in which there is often found a cavity running through the middle of the stalk and up into the head.

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STATE UNIVERSITY OF IOWA,
IOWA CITY, IOWA.

PLATE I

Dacryomyces minor

1. Habit sketch (X 2.5).
2. Two immature basidia with septa, a mature basidium without septa, two spores (X 1000).
3. Diagram of a longitudinal section (X 20).

Dacryomyces deliquescens

4. Habit sketch (X 2.5).
5. Diagram of a longitudinal section (X 15)
6. Two spores, one with sporidia (X 1000)

Dacryomyces Ellisii

7. Habit sketch (X 2.5).
8. Spore with sporidia (X 1000).
9. Diagram of a longitudinal section (X 10).

Calocera cornea

- 10 and 11. Habit sketches (X 2.5).
12. Two spores, one with sporidia (X 1000).
13. Diagram of a cross section (X 20).
14. Diagram of a longitudinal section (X 20).

PLATE II

Guepinia Spathularia.

15. Habit sketch (X 2.5).
16. Diagram of longitudinal section (X 7.5).
17. Diagram of a cross section (X 7.5).
18. Two spores, one with sporidia (X 1000).

Dacryopsis nuda.

19. Diagram of a longitudinal section (X 10).
20. Habit sketch (X 2.5).
21. Three spores, one with a sporidium (X 1000).

Guepiniopsis elegans

- 22 and 23. Habit sketches (X 2.5).
24. A portion of the mycelium, showing peculiar swellings (X 1000)
25. Spores with sporidium (X 1000).
26. Diagram of a longitudinal section (X 5).

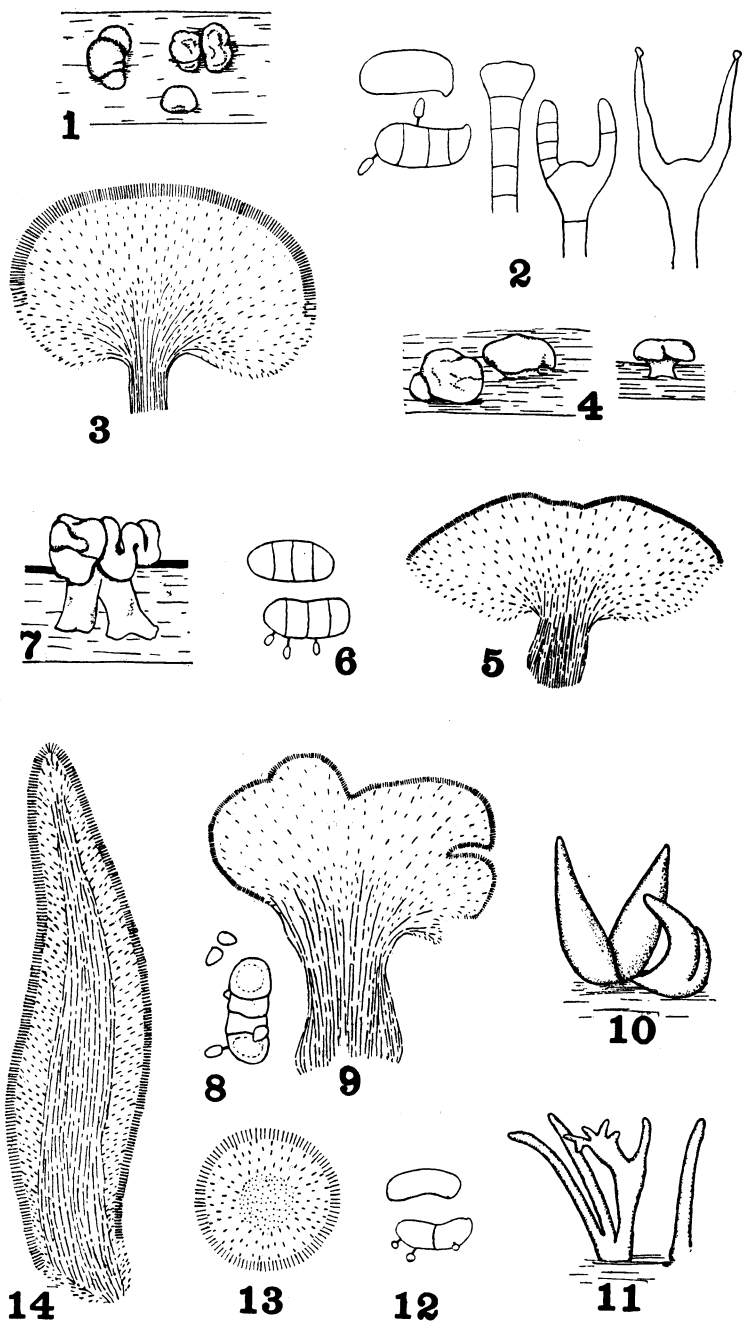


Plate I

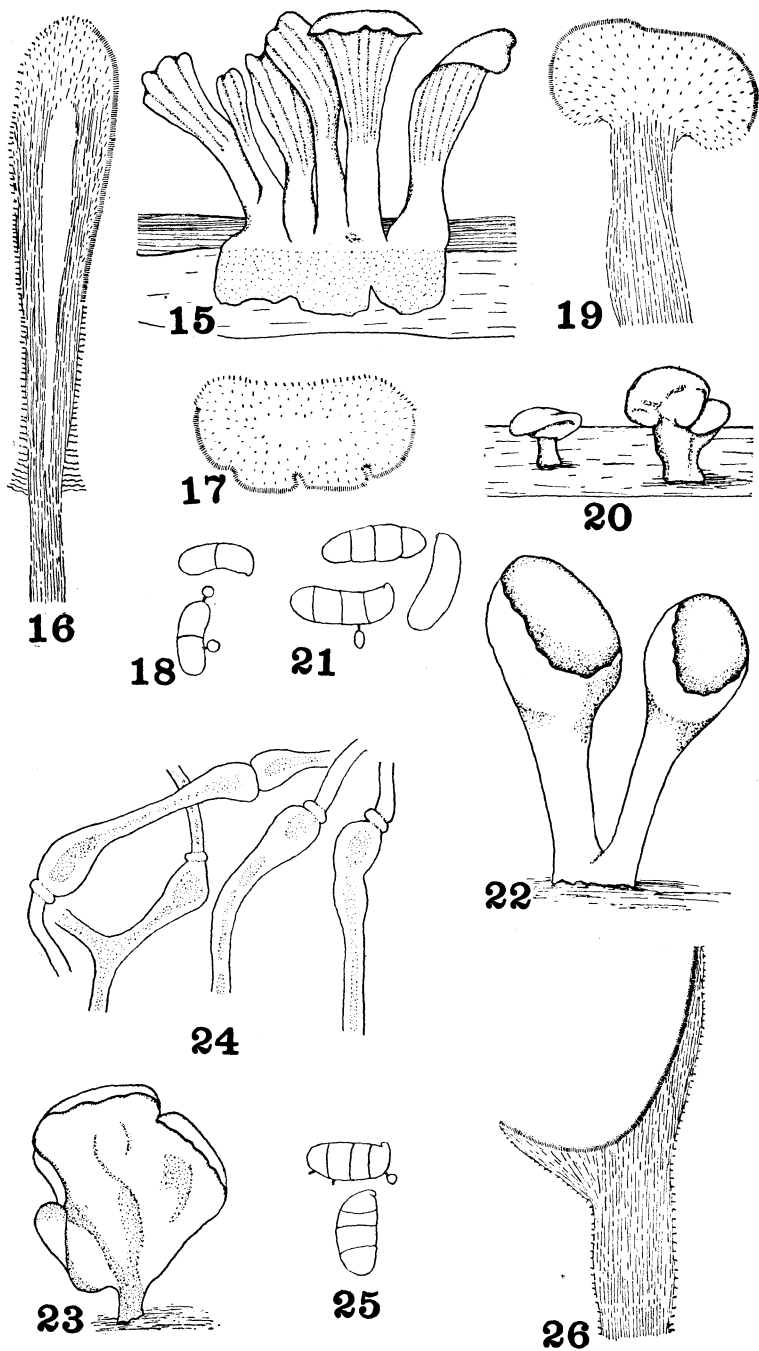


Plate II